



INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

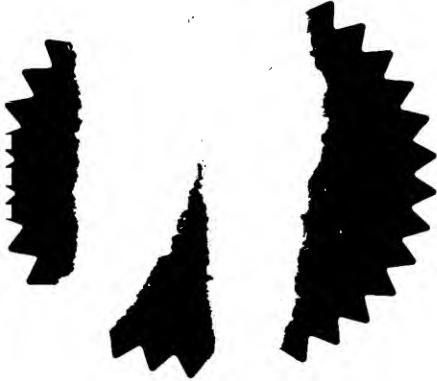
Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated

Andrew Garsley

25 February 2004





THE PATENT OFFICE

U 9 APR 2003

NEWPORT

The Patent Office

 Cardiff Road
 Newport
 South Wales
 NP10 8QQ
Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference

DY3118

 09APR03 E798951-1 D00370
 P01/7700 0.00-0308170.0

2. Patent application number

(The Patent Office will fill in this part)

U 9 APR 2003

0308170.0

3. Full name, address and postcode of the or of each applicant (*underline all surnames*)
 ROLLS-ROYCE PLC
 65 BUCKINGHAM GATE
 LONDON
 SW1E 6AT
Patents ADP number (*if you know it*)

3970002 II

If the applicant is a corporate body, give the country/state of its incorporation

ENGLAND

4. Title of the invention

A MOUNTING ARRANGEMENT AND METHOD

5. Name of your agent (*if you have one*)

M A GUNN

"Address for service" in the United Kingdom to which all correspondence should be sent
(including the postcode)

 ROLLS-ROYCE plc
 PATENTS DEPARTMENT
 PO BOX 31
 DERBY
 DE24 8BJ
Patents ADP number (*if you know it*)

396200

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (*if you know it*) the or each application number

Country

Priority application number
(*if you know it*)Date of filing
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

YES

- a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
 - c) any named applicant is a corporate body.
- See note (d))*

9. Enter the number of sheets for any of the following items you are filing with this form.
Do not count copies of the same document

Continuation sheets of this form

Description

11

Claim(s)

2

Abstract

1

Drawing(s)

2

8

2

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)

2

Request for preliminary examination and search (*Patents Form 9/77*)

1

Request for substantive examination (*Patents Form 10/77*)

1

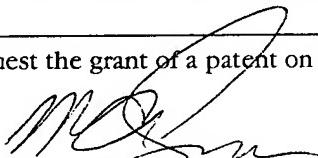
Any other documents
(please specify)

DEPOSIT ACCOUNT FEE SHEET

11.

I/We request the grant of a patent on the basis of this application.

Signature



Date

M A GUNN

8.4.2003

12. Name and daytime telephone number of person to contact in the United Kingdom

P D GEE

01332 249638

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

- a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
- b) Write your answers in capital letters using black ink or you may type them.
- c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- e) Once you have filled in the form you must remember to sign and date it.
- f) For details of the fee and ways to pay please contact the Patent Office.

ROLLS-ROYCE plc

CASE NO: DY3118

RR TITLE: [REDACTED]

APPLICATION NO:

DATED: 9 APRIL 2003

FIRST APPLICATION

DRAFTED BY: S&P FOR PDG

PATENTS ACT 1977

SPECIFICATION

A MOUNTING ARRANGEMENT AND METHOD

DUPLICATE

A Mounting Arrangement and Method

The present invention relates to mounting arrangements 5 for and methods of machining components such as turbine discs and compressor discs which may retain residual stresses after initial forging.

A number of components are initially cast or forged into an approximate shape for the final finished component. 10 Such an approach allows ease of manufacture as well as potential crystallography and material treatment to be achieved conveniently. The forged component such as a turbine disc is then machined appropriately in order to achieve the final component shape and surface finish. 15 Generally the original forged component only provides a rough approximation to the final finished shape and so a significant proportion of the forged material must be removed in order to achieve the desired finished shape.

Machining of the forged component is typically through 20 milling, turning or broaching whereby material is removed from the rough forged component until the desired finished shape is achieved. For example, Heyligenstaedt four-axis turning machines are known for providing the final machining of rough forged components into desired 25 compressor discs. Unfortunately, these machines are designed for high accuracy operation such that multiple abutment clamping of the component is necessary and normally a datum such as a flat surface is initially provided to the component to ensure surety of position and 30 therefore machined accuracy in the final product. Such robust and accurate assembly as indicated is highly beneficial with regard to high accuracy machining processes but with regard to machining initially rough forged components may be detrimental.

It will be understood that forged components generally retain residual stresses arising from the forging or casting process. These residual stresses cannot be relieved in the above forged component due to the high strength clamping inherent in machines such as Heyligenstaedt four-axis turning machines for accurate forming. In such circumstances, when the multi abutment clamping is released the final machine component may become distorted as these residual stresses are then relieved.

Such distortion clearly detracts from the desired shape profile for the component in its finished state.

In accordance with the present invention there is provided a mounting arrangement for machining components which may retain residual stresses, the arrangement comprising multiple point contact abutment clamping in use of a component, the arrangement characterised in that only three clamp pairs are provided to enable residual stress relief in use as the component is machined and incorporating a damper to augment vibration control otherwise diminished by the reduced contact clamping provided by only minimal contact abutment.

Preferably, each clamp pair is provided by opposed pairs of a clamping pad and a seating pad either side of the component. Typically, the clamping pad and/or the seating pads are configured for consistency with the presented component profile. Furthermore, such consistency may ensure appropriate approximate configuration of the component within the mounting arrangement. Advantageously, each clamp pair is adjustable in terms of presentation relative to the component.

Preferably the damper is perpendicular to the axial direction of contact abutment. Advantageously, the damper comprises a hydraulic ram and the damper member is held in contact with the component by a force. Typically, the

force will be variable. Generally, the force applied by the damper will be controlled dependent on sensed vibration and/or machining process step/regime and/or current process step and/or to facilitate an anti-phase cancellation 5 oscillation within the component to harmonic vibration beats. Normally the damper will comprise a contact finger. This contact finger may be made from elastomeric material or a metal contact or any other suitable means of providing contact for vibration de-coupling.

10 Also in accordance with the present invention there is provided a method of machining components which may retain residual stresses, the method comprising clamping a component with multiple point abutment contacts and thereafter machining the component, the method characterised in 15 that the component is only clamped by three clamp pairs and a vibration damper is applied to the component in order to augment vibration control due to machining of the component otherwise diminished by reduced contact abutments.

Typically the method in accordance with the present 20 invention comprises an initial machining process for removal of bulk material from a rough initial component and a final machining process with more resilient clamping of the component for more accurate machining of that component.

25 Generally, each clamp pair in accordance with the mounting arrangement and/or the method as described above allows slip movement of the component within the clamp pairs to relieve residual stresses within that component during machining.

30 An embodiment of the present invention will now be described by way of example with reference to the accompanying drawings in which:-

Fig. 1 is a schematic half cross-section of a mounting arrangement about a centre line X-X;

Fig. 2 is a schematic plan view of a whole mounting arrangement in the direction X-X depicted in Fig. 1; and,

Fig. 3 is a side view of the arrangement depicted in Fig. 2.

5 Referring to Fig. 1 which is a schematic cross-section of a mounting arrangement 1 in accordance with the present invention. Thus, the arrangement 1 comprises a clamp pair formed by abutment contact between a clamping pad 2 and a seat pad 3. The clamp pair creates a contact abutment in
10 order to clamp a component 4. This component 4 as illustrated in Fig. 1 is initially a rough forged component with an outline profile 5 but upon machining by means not depicted is rendered with a finished profile 6. Such machining can be by turning or other technique as required.
15 The component will be turned relative to a tool.

In order to provide clamping force an axial movement in the direction of arrowhead A is provided such that contact abutment is achieved between the clamping pad 2 and seating pad 3. Generally, this axial movement in the
20 direction of arrowhead A will be through a screw thread 7 driven by a worm gear or otherwise in order to create the necessary clamping force across the pair of clamping pad 2 and seating pad 3.

In accordance with the present invention a damper 8 is
25 provided which engages the component 4 in order to achieve vibration control. The damper 8 comprises a hydraulic ram 9 with a damper member 10 extending downwards into contact with a surface 11 of the component 4. Thus the damper 8 will damp vibrations created within the component 4 as it
30 is machined from the initial rough forged profile 5 to the finished profile 6.

In accordance with the present invention a minimum number of clamp pairs are provided in order to allow relief of residual stresses created within the component 4 as a

result of the forging or casting process. The minimum number of clamp pairs is three. Contact abutments created across opposed clamp pairs will normally be arranged with a 120° angle between clamp pairs, as the component 4 is 5 round. The number of clamping pairs provided will be three to present the component 4 to the appropriate turning device rather than resiliently secure consistent presentation of that component 4 throughout machining for accurate determination of the final profile 6. In such 10 circumstances residual stresses within the component 4 can be relieved by slip movement or other relief about the pads 2, 3 and between the clamping pairs created between the clamping pads 2 and seating pad 3. Residual stresses can be relieved during machining and upon release of the 15 finished or part finished component from the present clamping pairs there is less distortion of that component from the final machined shape 6.

In previous systems eight or more clamping pairs have been provided in order to mount the component with 20 sufficient resilient strength for consistent presentation but such resilient securing of the component 4 prevents relief of residual stresses in the component 4 during machining processes.

By provision of the minimum number of clamping pairs 25 to present the component to the machining device it will be understood that the component is thereby able to adjust in order to release the residual stresses caused by the forging process but also unfortunately will tend to vibrate to a far greater extent. Thus, the damper 8 augments 30 vibration control previously achieved through multipoint contact abutments with generally in excess of eight clamping pairs. In such circumstances the detrimental affects of vibration within the component 4 as it is machined from the initial rough profile 5 to the finished

profile 6 are inhibited. Vibration itself may cause erroneous machining of the component 4 so that such vibration control is necessary.

The present invention provides a "looser" presentation 5 of the component 4 to the machining device to allow relief of residual stresses but incorporates provision of a damper 8 in order to control vibration in association with the remaining clamping abutment contacts across a mounting end of the component 4.

10 Referring to Figs. 2 and 3 which schematically illustrate the mounting arrangement 1 in accordance with the present invention. Thus, three clamping pairs constituted by pads 2, 3 are provided to support the component 4 in an appropriate orientation so that the 15 component 4 may be turned in order to machine an area 20 to an appropriate profile. As indicated previously, the component 4 is generally rotated about an axis X-X. By providing three clamping pairs at equal spacing around the component 4 it will be understood that the component is 20 thereby reliably mounted but with an ability to adjust for stress relief. Typically, the component 4 will be a disc secured within a substantially vertical orientation with turning tools extending inwardly to machine the area 20. These tools would be presented in an opposed orientation 25 either side of the component 4 for balance. Generally, the clamping pairs will be adjusted to ensure appropriate vertical presentation of the component 4 for turning and machining purposes. As indicated in Fig. 3, generally the turning process will remove material from areas 21 in order 30 to shape the component 4 appropriately.

Three or more damper members 10 are generally associated in physical contact with component 4 in order to provide vibration control. As indicated above, such vibration control and contact can be through any

appropriate association such that the members 10 may be metal fingers or elastomeric contacts in appropriate engagement with the component 4. Damping control in accordance with the present invention is necessary due to 5 the much reduced resilience provided by only the minimal three clamping pairs provided.

Although only three clamping pairs are utilised in accordance with the present invention, it will be appreciated that these pairs will still hold the component, 10 4 and so inhibit relief of some stress retained within the component 4 as a result of the forging or casting process. In such circumstances, it is preferred in accordance with the present invention to initially turn the component held by the three clamping pairs to an approximation of the 15 desired final profile. Generally, this approximation will be within less than a millimetre of the desired final profile. Once in the approximation to the final profile the clamping pairs through pads 2, 3 will be released to allow the component to relax. This relaxation may result 20 in the component 4 expanding due to stress relief. Clearly, different components 4 will require different periods of time in order to relax for stress relief but nevertheless, after an appropriate period the component 4 will be remounted within the mounting arrangement 1 with 25 the three clamp pairs and the component then finally turned to the final desired profile 6 (Fig. 1).

As the component 4 is mounted by the clamping pairs through pads 2, 3 it will be understood that a rim periphery area 22 of the component 4 cannot be machined due 30 to interference with these pads 2, 3. In such circumstances, normally the component 4 will be released from the present mounting arrangement 1 and mounted in an alternative arrangement to allow appropriate machining of the component 4 in this area 22. This machining may

include milling, broaching or other techniques in order to create appropriate rim structures for the component 4. Normally, the rim structure of the component 4 will have a much greater cross-sectional diameter in comparison with 5 the relatively thin area 20 turned into a final profile whilst in the mounting arrangement 1. Thus, such more substantial structural thickness for radial dimension will limit the effects of residual stresses within the component in this area 22 of the component 4.

10 In view of the above, it will be appreciated that machining of a component 4 in accordance with the present invention will typically be of only two major operation cycles. A first utilising the present mounting arrangement 1 with only three clamping pairs in order to create the 15 thin central wall of the component 4 in the area 20 and a second operation cycle in order to create the rim structures such as blade mounting grooves, etc.

As indicated in Fig. 1 generally the damper 8 is arranged to be substantially perpendicular to the component 20 4. Such an arrangement is convenient in terms of accommodation within the clamping arrangement 1 and as depicted in Fig. 1 is generally consistent with the major plane of the component 4. In such circumstances, the damper 8 will provide appropriate vibration control without 25 impinging upon the surfaces of the component 4 which must be machined from the initial rough profile 5 to the final profile 6.

The damper 8 as indicated previously will typically comprise a hydraulic ram which extends the damper member 30 10 towards the surface 11 of the component 4. The force supplied or vibration absorption achieved through the damper member 10 and ram 9 may be variable. Such variability in vibration absorption and therefore control will render the clamping arrangement 1 more effective with

regard to actual vibration rather than predicted vibration. In such circumstances, the force supplied through the hydraulic ram 9 in order to create vibration control may be determined through sensing vibration within the component 4 and/or machining device process schedule in terms of current machining step as well as predictive anti-phase vibrations presented through the damper member 10 cancelling vibrations within the component 4 caused by machining operations. Possibly, the damper member 10 will be made from an elastomeric material such as rubber but any device which can engage into vibrational contact will be acceptable.

As indicated previously the number of clamping pairs which form contact abutments in accordance with the present invention will generally be limited to three which is the minimum to present the component 4 for appropriate machining but with sufficient laxity to allow the residual stress relief within the component 4 through the machining cycle. In such circumstances as described the minimum number of contact abutments is generally three in an approximate 120° relationship to each other. However, the specific number of contact abutments may be determined by actual requirements with the damper 8 supplementing in terms of vibration control and under performance by the reduced robustness of such clamping compared to previous arrangements.

A number of dampers are normally provided in engagement with the component 4 in order to achieve appropriate vibration control in association with the abutment contacts in clamping pairs in accordance with the present invention. The positioning of dampers may be determined by the particular shape of the component 4.

The present invention also incorporates a method of machining components from a rough profile 5 to a final

profile 6. The method incorporates mounting the component 4 in a clamping arrangement 1 such that there is the minimum number of contact abutments provided as opposed clamping pairs to present the component 4 for appropriate machining. Dampers 8 are then presented to the component 4 in order to augment vibration control achieved by the clamping pairs. In such circumstances, the component 4 subjected to the turning process can relieve residual stresses formed within the component 4 during initial forging or casting processes. The dampers 8 prevent vibration diminishing significantly machining accuracy to the final profile 6. In such circumstances, when the component 4 in the final profile 6 is released from the clamping arrangement 1 the residual stresses within the component have not been retained by the clamping arrangement 1 and so there is less if any distortion of the final profile 6 compared to the desired profile. However, advantageously, the method of the present invention may be used in order to achieve approximation of the final profile 5 using the present method in a first step and mounting arrangement and then the component 4 transiently released from that mounting arrangement and re-secured for a second step of accurate fine turning to the final profile 6. In such circumstances the bulk of residual stresses within the original component 4 and profile 5 are relieved by the present method.

Also in accordance with the present invention there is provision for further machining of the component 4 in order to create rim structures. Thus, the component 4 will be mounted in accordance with the arrangement 1 in order to provide initial turning and machining of the component 4 to the desired profile and then these mountings released and the component 4 mounted in an alternative arrangement in order to provide for machining such as milling, broaching

or another technique in order to create the rim structures as required. In such circumstances, the component 4 is appropriately machined by substantially only 2 machining processes as compared to the far greater number of 5 machining stages previously. It will also be appreciated that other structures could be machined into the component 4 in addition to rim structures.

The present invention allows by the arrangement or method accurate machining of a component 4 to a final 10 profile 6. Previously, in order to avoid the problems of distortion due to residual stresses within the component 4 it was not unusual to machine a component 4 in four or more processing steps whereby the component 4 is initially machined and then released to allow the distortion to 15 residual stresses and then the clamp/machine process again repeated until the final profile is achieved. The present invention allows closer approximation to that final profile or even achievement of that final profile with reduced machining steps and intervening release of the component to 20 relieve residual stresses. In such circumstances, the present arrangement and method facilitate greater efficiency of component machining operations from originally forged components.

Whilst endeavouring in the foregoing specification to 25 draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not 30 particular emphasis has been placed thereon.

CLAIMS

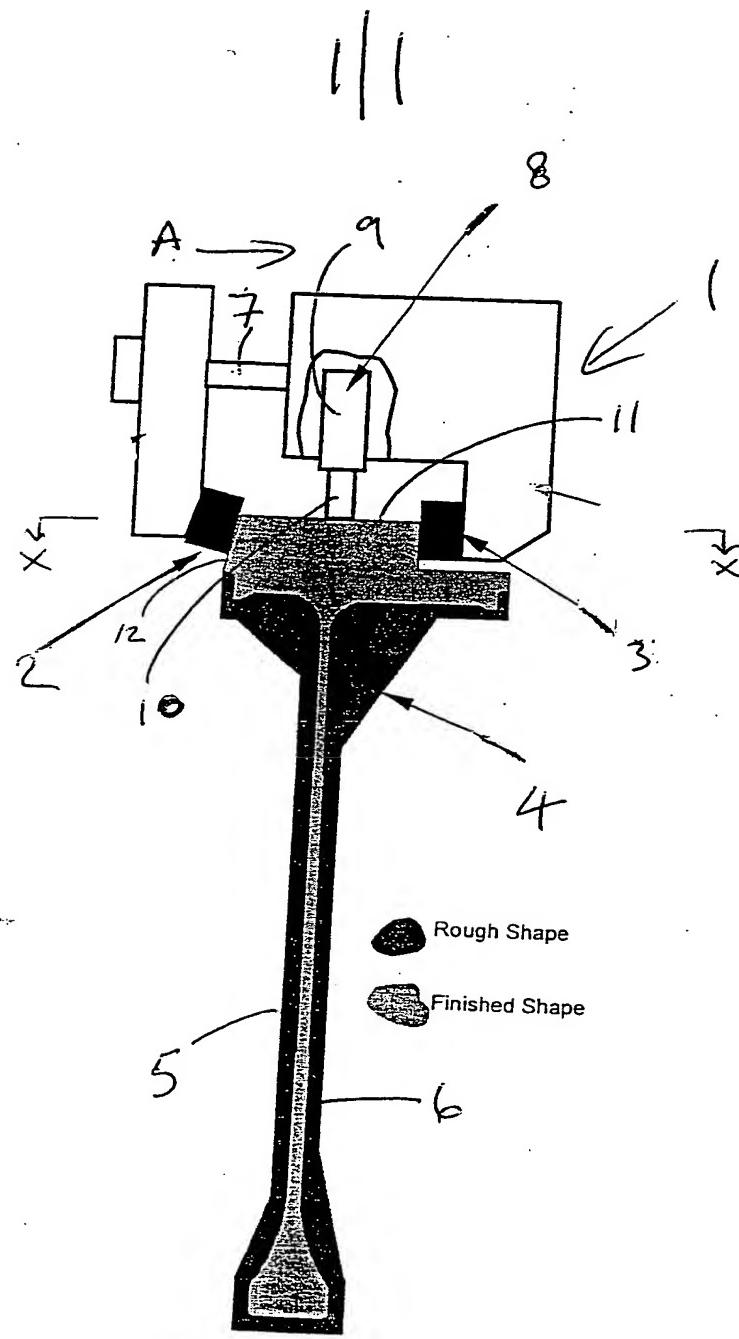
1. A mounting arrangement 1 for machining components 4 which may retain residual stresses, the arrangement comprising multiple point contact abutment clamping in use of a component, the arrangement characterised in that only three clamp pairs are provided to enable residual stress relief in use as the component is machined and incorporating a damper 8 to augment vibration control otherwise diminished by the reduced contact clamping provided by only minimal contact abutments.
2. An arrangement as claimed in claim 1, wherein each clamp pair is provided by opposed pairs of a clamping pad 2 and seating pad 3 either side of the component.
3. An arrangement as claimed in claim 2, wherein the clamping pad and/or the seating pad are configured for consistency with the presented component profile.
4. An arrangement as claimed in claim 3, wherein such consistency may ensure appropriate approximate configuration of the component within the mounting arrangement.
5. An arrangement as claimed in any preceding claim wherein each contact abutment is adjustable in terms of presentation relative to the component.
6. An arrangement as claimed in any preceding claim wherein the damper is perpendicular to the axial direction of contact abutment.
7. An arrangement as claimed in any preceding claim wherein the damper comprises a hydraulic ram 9 and the damper member 10 is held in contact with the component by a force.
8. An arrangement as claimed in claim 7 wherein the force will be variable.

9. An arrangement as claimed in claim 7 or 8 wherein the force applied by the damper will be controlled dependent on sensed vibration and/or machining process step/regime and/or current process step and/or to facilitate an anti-phase cancellation oscillation within the component to harmonic vibration beats.
- 5 10. An arrangement as claimed in any preceding claim wherein the damper will comprise a contact finger 10 of elastomeric material.
- 10 11. A mounting arrangement substantially as hereinbefore described with reference to the accompanying drawings.
12. A method of machining components 4 which may retain residual stresses, the method comprising clamping a component 4 with multiple point abutment contacts and there
- 15 15 after machining the component, the method characterised in that the component is only clamped by three contact abutments 2, 3 and a vibration damper 8 is applied to the component in order to augment vibration control due to machining of the component otherwise diminished by reduced
- 20 contact abutments.
13. A method as claimed in claim 11, wherein the method comprises an initial machining process for removal of bulk material from a rough initial component and a final machining process with more resilient clamping of the
- 25 25 component for more accurate machining of that component.
14. A method substantially as hereinbefore described with reference to the accompanying drawings.
15. Any novel subject matter or combination including novel subject matter disclosed herein, whether or not
- 30 30 within the scope of or relating to the same invention as any of the preceding claims.

ABSTRACTMounting Arrangement and Method

5

A mounting arrangement 1 is provided in which clamping pairs comprising a clamping pad 2 and seating pads 3 are arranged about a mounting end of a component 4. Thus, the component 4 is appropriately presented to a machining device but the component 4 can slip relative to the pads 2, 3 in order to relieve residual stresses in the component due to initial forging processes. A damper 8 is provided in order to augment vibration control in association with the contact abutments between the pads 2, 3. In such circumstances accurate machining of a component 4 to a final profile 6 from an initial rough profile 5 can be achieved more efficiently without periodic release of the component 4 so that distortions are avoided in the final component as a result of retained residual stresses by previous clamping.



Rough Shape

Finished Shape

Centre Line

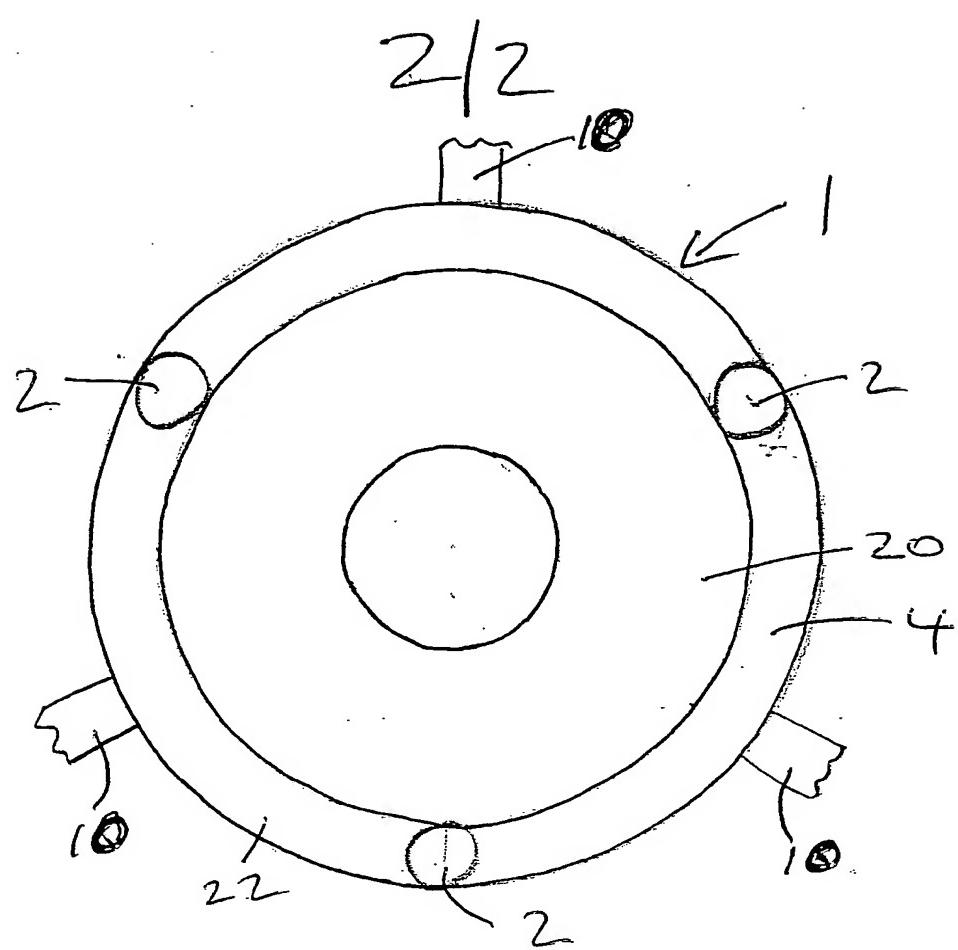


Figure 2

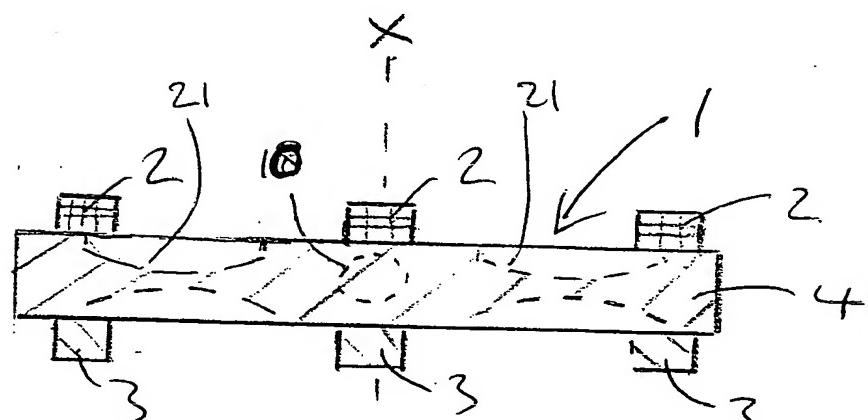


Figure 3